METHOD AND SYSTEM FOR MANAGING MEMORY
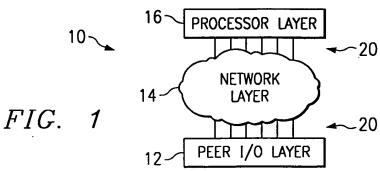IN A MULTIPROCESSOR SYSTEM

Inventors: Daniel E. Lenoski, et al.
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FIG. 1

FIG. 2

METHOD AND SYSTEM FOR MANAGING MEMORY
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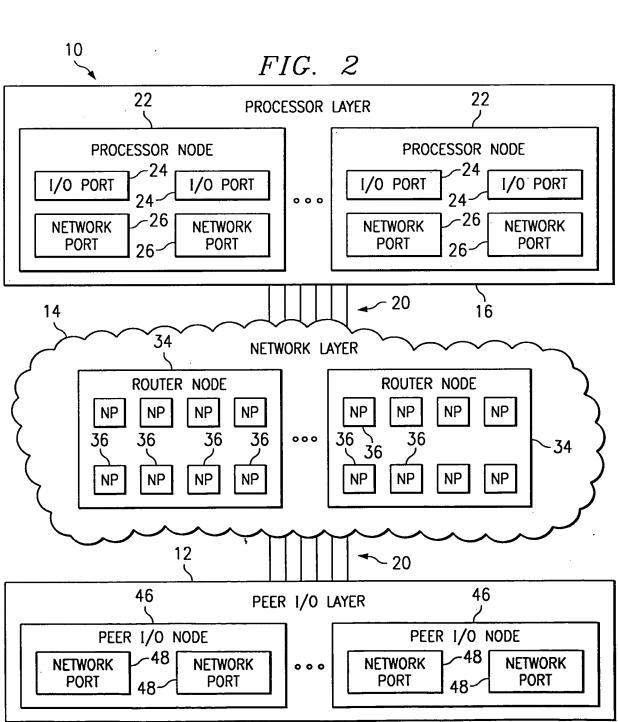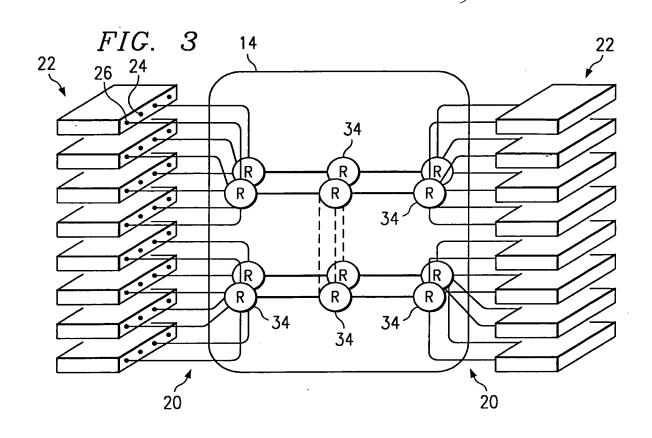
FIG. 3

FIG. 5

FIG. 6

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FIG. 4

FIG. 7

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FIG. 8

PROCESSOR LAYER

200

202   202   202

22 ... 22   22 ... 22   22 ... 22   22 ... 22

202

22 ... 22

16

NETWORK LAYER

34   34

14   12

34 ... 34

204

PEER I/O LAYER

46   46

46 ... 46

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900

	GROUP	NAME	DESCRIPTION	
		902	904	906

	GROUP		NAME	DESCRIPTION	
910	**READ**	SHARED	READ	READ	910a
			RDSHD	READ SHARED	
		EXCLUSIVE	RDEXC	READ EXCLUSIVE	910b
			RDXRO	EXCLUSIVE READ-ONLY TIMED	
			RDXRN	EXCLUSIVE READ-ONLY UNTIMED	
		GET	GET	READ INVALID	910c
			GETF	READ INVALID, FORCED	
		etc.	AMOR	ATOMIC MEMORY OPERATION, READ	910d
			NCRD	NON-COHERENT READ	
912	**WRITE**	WRITEBACK	WRBK	WRITEBACK	912a
			WRBKR	WRITEBACK, CONCURRENT READ OUTSTANDING	
			IWE	IMPLICIT WRITEBACK EXCLUSIVE	
			RQSH	CEX DROP (RELINQUISH)	
			RQSHR	CEX DROP, CONCURRENT READ OUTSTANDING	
		PUT	PUT	WRITE INVALIDATE	912b
			PFCL	CACHE LINE FLUSH	
		ETC.	AMOW	ATOMIC MEMORY OPERATION, WRITE	912c
			NCWRD	NON-COHERENT WRITE, DOUBLEWORD	
			NCWRF	NON-COHERENT WRITE, CACHE LINE	
914	**PROBE**	SHARED	INTER	INTERVENTION SHARED	914a
		EXCLUSIVE	INEXC	INTERVENTION EXCLUSIVE	914b
			FLSH	FLUSH	
			ERASE	ERASE	
		GET	ININV	INTERVENTION INVALID	914c
			ININF	INTERVENTION INVALID, FORCED	
		ETC.	INVAL	INVALIDATE	914d
916	INVAL GENERATION		BINEV	BACKOFF INVALIDATE ECHO, VECTOR FORMAT	
			LINV	LOCAL BLOCK INVALIDATE VECTOR	

FIG. 9

METHOD AND SYSTEM FOR MANAGING MEMORY
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FIG. 1OA

1000   1002   1004   1006

	GROUP	NAME	DESCRIPTION	
		SRPLY	SHARED REPLY	
	SHARED	SRESP	SHARED RESPONSE	1010a
		SACK	SHARED ACKNOWLEDGE	
		BINTR	BACKOFF INTERVENTION SHARED	
		ERPLY	EXCLUSIVE REPLY	
		ESPEC	EXCLUSIVE SPECULATIVE REPLY	
		ERESP	EXCLUSIVE RESPONSE	
		EACK	EXCLUSIVE ACKNOWLEDGE	
	EXCLUSIVE	ERPYP	EXCLUSIVE REPLY, SEND PRGE	1010b
		BIEXC	BACKOFF INTERVENTION EXCLUSIVE	
		BINVV	BACKOFF INVALIDATE, VECTOR FORMAT	
READ		BINVP	BACKOFF INVALIDATE, POINTER FORMAT	
		IRPLY	INVALID REPLY	
		ISPEC	INVALID SPECULATIVE REPLY	
		IRESP	INVALID RESPONSE	
	GET	IACK	INVALID ACKNOWLEDGE	1010c
		NACKG	NEGATIVE ACKNOWLEDGE TO GET	
		BIINV	BACKOFF INTERVENTION INVALID	
		BIINF	BACKOFF INTERVENTION INVALID FORCED	
		AARP	AMO READ REPLY	
	ETC.	NCRP	NON-COHERENT READ REPLY	1010d
		NACK	COHERENT READ NEGATIVE ACKNOWLEDGE	
	WRITEBACK	WBACK	WRITEBACK ACKNOWLEDGE	1012a
		WBBACK	WRITEBACK BUSY ACKNOWLEDGE	
WRITE		WACK	WRITE INVALIDATE ACKNOWLEDGE	
	PUT	WACKP	WRITE INVALIDATE ACK, SEND PRGE	1012b
		WNACK	WRITE INVALIDATE NEGATIVE ACKNOWLEDGE	

1010 { READ
1012 { WRITE

TO FIG. 10B

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FIG. 10B

FROM FIG. 10A

1000

WRITE (1012)	PUT	BFLSH	BACKOFF FLUSH	1012b
		BERSE	BACKOFF ERASE	
	ETC.	AWAK	AMO WRITE ACKNOWLEDGE	1012c
		NCWAK	NON–COHERENT WRITE ACKNOWLEDGE	
PROBE (1014)	SHARED	SHWB	SHARING WRITEBACK	1014a
		DNGRD	DOWNGRADE	
		SHWBR	SHARING WRITEBACK, PRIOR WB PENDING	
		DNGDR	DOWNGRADE WITH PRIOR WB PENDING	
	EXCLUSIVE	PRGE	PURGE	1014b
		XFER	OWNERSHIP TRANSFER	
		PRGER	PURGE WITH PRIOR WB PENDING	
		XFERR	OWNERSHIP TRANSFER, PRIOR WB PENDING	
		IWACK	IMPLICIT WRITEBACK RACE ACKNOWLEDGE	
	GET	IIACK	INTERVENTION INVALID ACK	1014c
	ETC.	IVACK	INVALIDATE ACK	1014d
ERROR (1016)		PERR	POISONED ACCESS ERROR	
		AERR	READ PROTECTION VIOLATION ERROR	
		WERR	WRITE PROTECTION VIOLATION ERROR	
		DERRR	DIRECTORY ERROR ON A READ REQUEST	
		DERRW	DIRECTORY ERROR ON A WRITE REQUEST	

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FIG. 11

START

1100 — RECEIVE REQUEST TO ACCESS DATA

1102 — DETERMINE STATUS OF REQUEST

1104 — STATUS = SHARED? — NO

YES

1106 — DETERMINE COHERENCE DOMAIN FOR REQUESTER

1108 — AUTHORIZED COHERENCE DOMAIN ? — YES

NO

1110 — DENY REQUEST

1112 — SEND ERROR MESSAGE

RESPOND TO REQUEST — 1114

END